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Neuromuscular control and lateralization in the game of tennis

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Abstract

Our research aimed to measure the laterality type of tennis players and its role in controlling their muscles. The study was conducted on a batch of 62 athletes, aged between 10 and 18 years (average age = 14.18 years, SD = 2.22). The evaluation of lateralization was performed in two steps: measuring (a) the level of gross and fine motor skills using a tapping and marking test and (b) the level of neuromuscular control using a condition simulator with two tasks (coordination at low speed and coordination at high speed). Statistical analysis revealed a positive relation between the laterality type of the probed athletes and their results in the condition simulator at high speed coordination. The study indicated that athletes who feature left hand laterality or are ambidextrous have a higher level of neuromuscular control than athletes who distinguish themselves by right hand laterality.

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Key words: ambidextrous; control; coordination; simulator; tennis.

1. Structure

Tennis is currently one of the most publicized sports in the world. The factors that distinguish top athletes from medium class players are mainly their level of adaptation to challenging situations and their reaction time in time-critical situations. Since these factors are extremely difficult to assess, objective methods of measurement are used, particularly for their evaluation. These objective methods are designed to highlight correctness and educational development of the coaching process in collaboration with the technical team. Motor learning is an internal process related to practice and experience, permanently directed by changes and modifications of one's aptitudes. (Coker & Fischman, 2010). Motor performance is influenced by decision, perception and action. (Landers & Arent, 2010). In order to obtain the most efficient development in sports, acquiring the act, action or motor skills are essential, no matter the practiced type of sport. Moreover, the execution of a certain technique in sport according to an individual's particularities can be of great help for the coach during the instructional-

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educative process. The efficiency of movements requires their stability over time. The stability of movements or Movement control develops during childhood, allows identifying potential talents in performance sports and considerably benefits to the player´s physical health (Vandarpone et al. 2012). Assessing motor control in early stages of infancy may become the one of the most important selection criteria according to requirements of the respective sport. Bastik et al. 2012, Pizzera & Raab 2012, Grigore et al. 2011 have conducted studies about the role of the coordination control and its substantial differences in efficiency for different kind of sports. As each sport has its own particularity, we cannot assert that a certain type of movement is generally favorable for all sports. Thus, the intention of this study is to shed light on neuromuscular control in tennis. Motor control is differently developed according to age.

Motor control coordination is increasing over time (Vandorpe, 2012) but it becomes regressive with age, especially at very old ages. (Przybyla, 2011). Motor control depends on time until a certain age is reached, therefore the initiation in developing coordination will start during childhood, and this period of progress will last until the adult age, being followed by regression. A model of motor control is formulated by Murphy et al. (2007) and explains its efficiency through individual differences, visual and spatial system, as well as through sensitivity of internal and external stimuli, attention, behavior, emotions and cognition. Athletes must especially learn to coordinate their movements in challenging situations (Button et al. 2011). They have constructed a diagram of human movement control based on the Bernstein's model from 1967. Voelcker-Rehage (2008) proposed a scheme of motor aptitudes according to structure, complexity, difficulty and familiarity. The coordination efficiency can be explained separately according to the subject's dominating arm. Hughes (2011) evaluated the differences between left-handed and right-handed people according to the brain hemisphere sighting a transportation task. Left and right handed people varied in completing tasks from the total scores. Tennis is a sport in which the requirement to coordinate lower and upper limbs is very high. This task was better achieved by left handed people.

The speed with which the player moves to the ball, his position according to the ball's placing, the way he hits the ball, the racquet-ball impact - all these aspects make the crucial difference between medium and top level players in terms of speed and precision. In tennis, movement control is represented by the player's constant in efficiently hitting during a game. One of the starting points in tennis consists of identifying the player's laterality. Gariphuy (2001) makes several observations related to the difficulties that occur during this process. There are players with right dominant arm and left dominant leg or left dominant arm and right dominant eye. Crespo et al. (2009) describe arm – eye coordination, reaction time, spatial orientation as determining factors of performance success in tennis. Developing these aptitudes will lead to improving the player's performance. The motor control in the play might be explained with a device that objectively measures the sighted movements. Ivancevic et al. 2011 relate this mechanism to neuromuscular control and offer several bio-mechanic and mathematic landmarks in order to calculate it as precisely as possible.

2. Methods

The study was conducted on a batch of 62 athletes, aged between 10 and 18 years (average = 14.18 years, SD = 2.22), out of which 29 were boys and 33 were girls. Our research was made with the help of a conditions simulator. This simulator is composed by a monitor and a traction bar which is wired to the monitor in order to transmit the data in real-time. The participant sits on a chair, facing a screen that displays a graphic profile. He must execute a traction movement, from top to bottom, trying to determine the shifting of a point which follows the displayed graphic profile. The participant views the effects of his actions on the screen during the whole movement, based on the received data, and has the possibility to control and permanently adjust his movement to follow the given model as accurately as possible. During this process the high-speed neuromuscular control was monitored (10 % break) along with the low-speed control (80% speed), each task being repeated 20 times. Assessment of neuromuscular control was achieved after scoring system devised by Hillerin 2011 and presented in detail in an article International Conference. (Mosoi, Botezatu, Ciurea2011). The scoring system was based on the following formula:

$$N_{med} = \frac{\sum_{i=1}^{n}\left(\sum_{s=0}^{P\,max,i} N_{s,i}\right)}{\sum_{i=1}^{n} P_{max,i}}; \text{where:}$$

N_{med} = the mean scores for the entire exercise

$N_{s,i}$ = value of scores for each position and repeat;

n = repetitions number;

$P_{max,i}$ = maximum points score for each repeat; and

$$N_{s,i} = 10 \times \left(1 - \frac{|\Delta_{s,i}|}{M_s}\right);\ \text{where: } \Delta_{s,i} = \begin{cases} F_{s,i} - M_s \text{ for} \\ 0 \le F_{s,i} \le 2M_s \\ 0 \text{ for } F_{s,i} > 2M_s \end{cases} \quad \text{and}$$

$F_{s,i}$ = value for each repeat i in the s position;

M_s = model value in the s position; (cf. Hillerin, 2011).

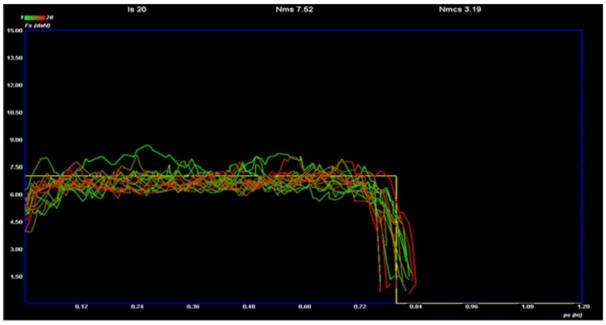

Fig. 1 - Break.80%

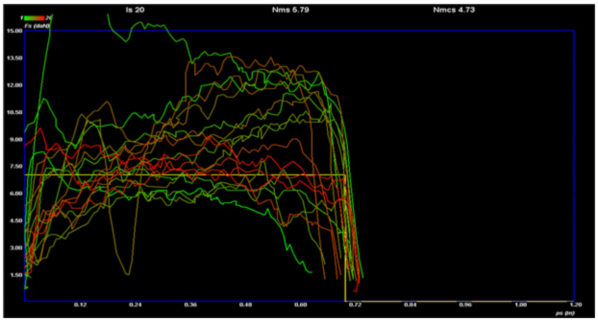

Fig. 2 - Break.80%

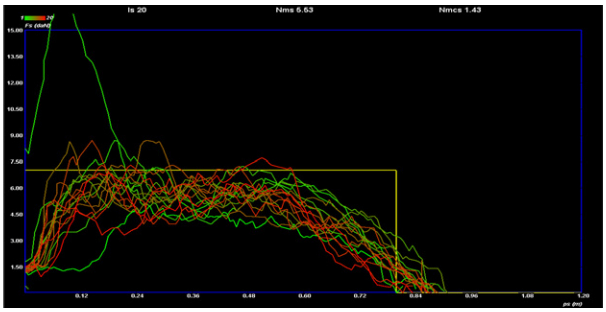

Fig. 3 - Break .10%

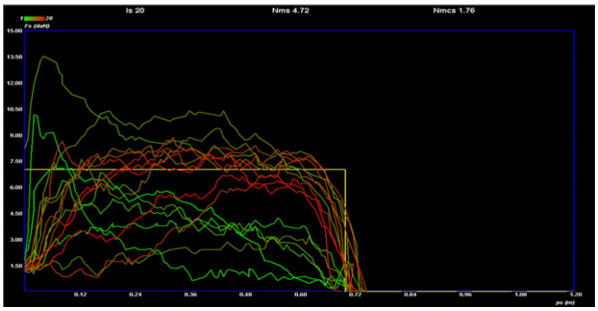

Fig.4 - Break .10%

The previous figures show the differences between two players. The first player (figures 1rd and 3th), demonstrates a high level of neuromuscular control for the first task (80 break) and a medium level of control for the second task (10 break), and the 2rd and 4th graphics show the control level of the second player based on the described tasks. The difference between the two playes is extracted from the way they drew the line according to the proposed graphic model. The more this graph is straight, the more correct the task was completed. Each execution is given a score, and at the end of the task a total score is calculated. At the end of the simulation tasks both tasks were summed in one score. In order to identify the player's dominating arm and lateraly, the participants went through a tapping and tracing task. The tapping taks (coarse coordination – to tap as many points with a pen, in a square) was made in a 10 seconds time for each hand and the tracing task (finer coordination – tracing straight vertical lines) in a 6 seconds time for each hand. The scores of each task were calculated, for each hand separately. Atfer all the completed tasks, the total score for each hand determined the laterality based on three cathegories: right-handed, left-handed and ambidextrous. The Anova method and liniar correlation were used to process the results.

3. Results and discussions

The subjects were divided into three groups according to their laterality results. 28 subjects were left-handed, 24 were ambidextrous and 10 players were left-handed.

Table 1. Descriptive results

		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Simulator.total.1+2	Left-handed	10	14.8040	.68793	.21754	14.00	16.02
	Ambidextrous	24	13.6558	1.34779	.27512	10.11	15.89
	Right-handed	28	12.6782	1.71465	.32404	9.28	15.79
	Total	62	13.3995	1.62607	.20651	9.28	16.02
Break simulator10.2	Left-handed	10	6.7670	.58623	.18538	5.99	7.64
	Ambidextrous	24	5.9717	.69846	.14257	4.81	7.38
	Right-handed	28	5.5186	.96135	.18168	3.40	7.46
	Total	62	5.8953	.91418	.11610	3.40	7.64
Break simulator 80.1	Left-handed	10	7.9760	.36244	.11461	7.40	8.38
	Ambidextrous	24	7.7375	.65506	.13371	6.38	8.98
	Right-handed	28	7.5400	.21099	.03987	7.27	8.00
	Total	62	7.6868	.47486	.06031	6.38	8.98

According to the table, there is no difference given by the task completed by the participants. The left-laterity participants show a higher level of neuromuscular control during both tasks, the minimum core treshold is higher then in the case of ambidextrous or right-handed players. Same results were registered for the high execution speed based on control, the 10 break task. The homogenity Levene test has shown that at the level of low break simulator (10), the dispesions in the three groups are homogenous and for the total score of the tasks, the Levene test has given the minumum acceptance result, 811, p = .049.

Table 2. The Anova table

Simulator task	Column A (F)	Column B (*df*)	Column C (*p≤.001)*	Column D (*eta squared*)
10 Break Simulator	8.79	2	.000	.22
Total Simulator Score	8.42	2	.001	.22

According to the table, we may assert that the simulator score for the second score (10 break) and the total score vary depending to the player's laterality. For these tasks, laterality shows a low level of influence.

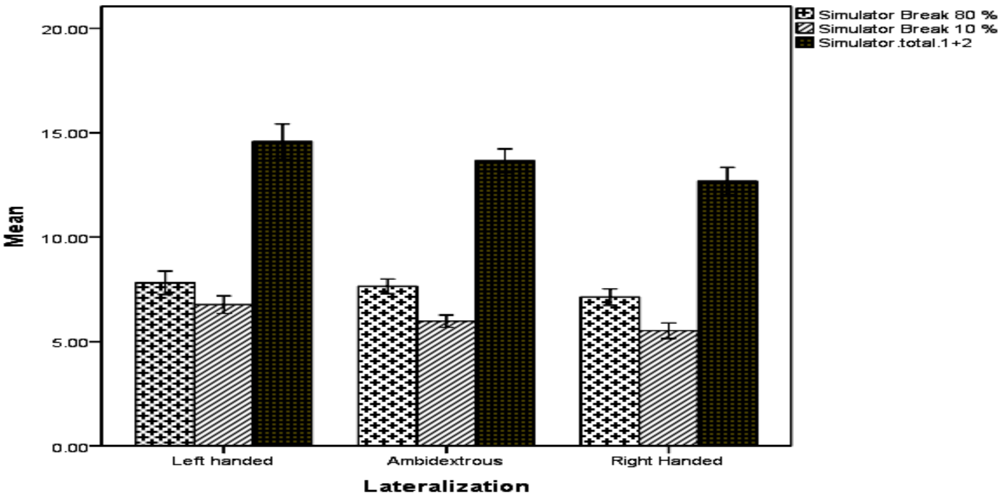

Fig. 5 Mean scores obtained by the simulator test for the different types of laterilazation.
total score (black bars), simulator break 10 (striped diagonal bars), simulator break 80 (bars with plus)

As it is noticed in the table, left-handed players have obtained higher scores compared to the other 2 groups for all three tasks. For these tasks the difference between the groups was also calculated. It was noticed that the score of left-handed players was different from the scores of right-handed players in both given tasks, with a significance threshold of $p = .000$. Ambidextrous players only differ from left-handed players: $p = .036$. To analyze the degree of association between the simulator and scores obtained during the motor coordination tests we used the Pearson analysis. Three significant linear correlations were shown, for the right-left tracing tasks, with a negative score of $r = -.42$, $p = .001$, ($p \leq .001$), at the right-left tapping task, $r = -.34$, $p = .006$ ($p \leq .05$) and the tapping and tracing difference task for the right hand $r = -.34$, $p = .006$ ($p \leq .05$). these negative correlations show that the simulation score (total of points) will be higher as the difference between the left and the right hand will be smaller or the score difference for the same hand will be lower during the tasks. In the case of low break simulator, evaluating the adaptation level to higher levels, same tasks were identified as the ones previously presented but with different correlations, therefore, at the right-left tracing task, $r = -.42$, $p = .001$, at the right-left tapping task, $r = -.39$, $p = .002$ ($p \leq .05$), and the difference between tapping and tracing tasks for the right hand $r = -.32$, $p = .011$ ($p \leq .05$). The results show that the players who obtained a very good score for the 10 break simulator are associated with a low score for the previously described tasks. At the age-group level, differences between players aged 10-12 and players over 16 were noticed. The level of aptitudes development depends on age. Voelcker-Rehage (2008).

Conclusions

Our results have highlighted differences between the laterality of the players and their efficiency in the neuromuscular control task. In the case of high break task (80), there were no differences between the tennis players. We found positive correlations between the simulator and the coordination tasks. Players who have a highly developed left arm obtained higher scores in the 10 break simulator and in the total task simulator than the other two laterality types whereat right hand players scored lowest. Likewise, tapping and tracing results varied strongly among laterality types: players who are left-handed or ambidextrous achieved very good results at the simulator tests. Consequently, the applied analysis in this study can contribute essentially to the selection process in tennis. Promoting the same laterality types, the trapping and tracing test is a cost-effective, efficient and easy applicable method to assess coordination/motor skills of players in opposition to the simulator test whose application is constrained only to top athletes.

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